47. GUNNERSON, C & KALBERMATTEN, T. (Editors), (1978). Appropriate Technology in Water Supply and Waste Disposal. ASCE, New York.

48. HANSEN, L. & ROSENHALL, L. (1979). Evaluation of Rural Water Supplies in Eastern and Southern Africa. Proceedings of Symposium on Engineering Science and Medicine in the Control of Tropical Water-related Diseases. Pergammon Press, Oxford, UK.

49 HARRIS, R.B. (1986). Howard Humphreys and Partners, Consulting Civil Engineers, UK. Personal Communication.

50. HOLLOWAY, J.M. (1970). Development of Rural Water Supplies in Tanzania. Proceedings of the ICE, Vol 45, pp641-660. ICE, London.

51. HOOLE, K. (1984). Air Voids in Small Diameter Pipes. MSc Thesis, WEDC, Loughborough University of Technology, England.

52. HOWARTH, D.A. (1983). The Role of Development Banks in International Funding. In, Water Supply and Sanitation in Developing Countries. IWES, London.

53. HUISMAN, L. & WOOD, W.E. (1974). Slow Sand Filtration. WHO, Geneva.

54. HUSTON, P. (1985). Taking Time. In Decade Watch, Vol 4, No. 2. WHO, Geneva.

55. HUTTON, L.G. (1983). Field Testing of Water in Developing Countries. WRC, UK.

56. ILO, (1986). The Participation of the Rural Poor in Development. ILO, Geneva.

57. IMBODEN, N. (1977). Planning and Design of Rural Drinking Water Projects. OECD Development Centre, Paris.

58. IDWSSD, (1983). Trends in External Support to the IDWSSD. WHO, Geneva.

59. IRC/GUINEA GOVERNMENT, (1982). Experiences from the Buba-Tombali Water Project in Guinea-Bissau, 1978 to 1981. IRC, The Hague.

60. The IDTG WATER PANEL, (1980). Giuidelines on Planning and Management of Rural Water Supplies in Developing Countries. Appropriate Technology, Vol 7, No 3. IT Publications, London.

61. JORDAN, T.J. (1984). A Handbook of Gravity-Flow Water Systems. IT Publications, London.

62. KALBERMATTEN, J.M. et al, (1980). Reprt Series on Appropriate Technology for Water Supply and Sanitation. Volume 1, Technical and Economic Options. World Bank, Washington, DC.

63. KINLEY, D. (1986). Haiti Adopts Low-Cost Solutions to its Water Problems. In, Waterlines, Vol 4, No 3. London.

64. KINNERSLEY, D.J. (1983). Institutional Requirements. In, Water Supply and Sanitation in Developing Countries. IWES, London.

65. LACKINGTON, D. (1985). Severn Trent Water Authority. Invitation Lecture at WEDC, Loughborough, England.

66. LAURIA D.T. et al, (1978). Intermediate Service Levels in Water Distribution. In, Appropriate Technology in Water Supply and Waste Disposal. ASCE, New York.

67. LIPANGILE, T.N. (1985). Bamboo Water Pipes. In, Waterlines, Vol 3, No 4. London.

68. LIPTON, M. (1977). When Poor People Stay Poor; Urban Bias in Third World Development. Temple Smith, London.

69. MCNEILL, D. (1974). Manual for the Appraisal of Rural Water Supplies. ODA, London.

70. MARA. D. (1982). Appropriate Technology for Water Supply and Sanitation; Sanitation Alternatives for Low Income Communities. World Bank, Washington, DC.

71. MAUNDER, P. (1985). Department of Economics, Loughborough University of Technology. WEDC, MSc Lecture Notes.

72. MUNTHALI, L.W.C. & KAMWANJA, G.A. (1981). Operational Maintenance in Malawi. In, Rural Water Supply in Developing Countries. Proceedings of a Workshop on Training in Zomba, Malawi. IDRC, Canada.

73. NEPAL, HMG. (1982). Standard Proceedures for the Implementation of Rural Water Supply Projects. MPLD/UNICEF, Kathmandu, Nepal.

74. NEW ERA, (1977). Community Water Supply; Status Report. Volume V: Summary. MPLD/UNICEF, Kathmandu, Nepal.

75. OLDCORN, R. (1982). Management, A Fresh Approach. Pan Books, London.

76. OKUN, D.A. (1982). Surface Water Treatment. Chapter 2 in, Water Supply and Sanitation in Developing Countries. Ann Butterworths Ltd., Kent, England.

77. PACEY, A. (1977). Water For the Thousand Millions. Pergammon Press, Oxford, UK.

78. PALMER, C.F. (1986). Management Techniques to Optimise Repetitive Operations in Small Water Supply Schemes. Jounal of IWES, Vol 40, No 3. IWES, London.

79. PESCOD, W. (1983). Low Cost Technology. In, Water Supply and Sanitation in Developing Countries. IWES, London.

80. PESCOD, W. (1984). Privatisation of Rural Water Supplies in Developing Countries. Waterlines, Vol 3, No 2. London.

81. PICKFORD, J. (1982a). Low-Cost Water Supply and Sanitation for Low Income People. Public Health Engineer, Vol 10, No 3. IPHE, London.

82. PICKFORD, J. (1982b). People and the Decade: Technology and Community. Waterlines, Vol 1, No 2. London.

83. PICKFORD, J. (1984a). Training People to meet the Global Need. In, Water and Sanitation, Economic and Sociological Perspectives. Academic Press, London.

84. PICKFORD, J. (1984b). Good Hardware Plus Good Software Equals Successful Implementation. Waterlines, Vol 2, No 3. London.

85. POLLOCK, J.B. (1983). Final Report on the 1983 Work Season. MPLD/UNICEF, Nepal. (Unpublished).

86. RAMAN, V. (1978). Assessment and Control of Leakages in Distribution Systems: Case Studies in India. Aqua, No 4, pp43-51. London.

87. REED, R.A. (1986). WEDC Group, Deparment of Civil Engineering, Loughborough University of Technology. Personal Communication.

88. REID, G.W. (1982). Water and Wastewater in Developing Countries. Butterworths Ltd., Kent, UK.

89. ROARK, P.D. (1984). Women and Water. In, Water and Sanitation, Economic and Sociological Perspectives. Academic Press, London.

90. SAKYA, B.R. (1984). Regional Directorate Maintenance Section, Mid Season Progress Report. MPLD, Nepal. (Unpublished).

91. SANSTAG, T. (1983). UN Abandon Water Decade. The Times, 13th July, p5. London.

92. SATA/ GOVERNMENT OF CAMEROON, (1980). Manual for Rural Water Supply. Community Development Department, Ministry of Agriculture, United Republic of Cameroon. SATA, Zurich.

93. SAUNDERS, R.J. & WARFORD, J.J. (1974). Village Water Supply and Sanitation in Less Developed Countries. Public Utilities Report No. Res 2. World Bank, Washington, DC.

94. SAUNDERS, R.J. & WARFORD, J.J. (1976). Village Water Supply: Economics and Policy in the Developing World. John Hopkins University Press, Baltimore, USA.

95. SCHRAMM, W. & GURUNG, L. (1981). Proposal for a Feasible Maintenance and Repair Management System for the Rural CWSS Programme in Nepal. SATA, Kathmandu, Nepal.

96. SCHULTZ, P. (1986). Public Utilities Corporation (Water), Kiribati. Personal Communication.

97. SCHUMACHER, E.F. (1965). Small is Beautiful. Blond and Briggs, London.

98. SHIPMAN, H.R. (1972). Policies Affecting the Financing of Urban Water Supply in Developing Countries. International Standing Committee on Problems of Water Supply in Developing Countries, Subject No 2. World Bank, Washington, DC.

99. SMITH, M.D. (1985). WEDC Group, Department of Civil Engineering, Loughborough University of Technology. MSc Lecture Notes.

100. STRAUSS, M. (1983). Community Water Supply and Sanitation Programme in The Western Development Region of Nepal. IRCWD News, No 18/19. Switzerland.

101. TILLMAN, G. (1981). Environmentallly Sound Small-scale Water Projects; Guidelines for Planning. Codel/VITA, New York.

102. THOMAS, E.G. (1986). Sir William Halcrow and Partners, Consulting Civil Engineers, UK. Personal Communication.

103. TODARO, M.P. (1985). Economic Development in The Third World. Longman, London.

104. UNITED NATIONS, (1976). Technical Cooperation Among Developing Countries with Regard to Water Resources Development. E/CONF.70/12. UN, New York.

105. UNDP, (1981). Decade Dossier. UNDP, New York.

106. URBAN EDGE, (Editorial), (1983). Water's uncertain Decade of Development. Vol 7, No 8. World Bank, Washington, DC.

107. VAN DAMME H.M.G. & WHITE, A. (1984). Technology Choices for the Decade. In, Water Supply and Sanitation; Economic and Sociological Perspectives. Academic Press, London.

108. VAN NORDEN, H. (1982). UNICEF Field Engineer, Nepal. Personal Communication.

109. VAN WIJK-SIJBESMA (1985). Participation of Women in Water Supply and Sanitation; Roles and Realities. WHO-IRC Technical Paper Series 22. WHO-IRC, The Hague.

110. VERHOOG, F.H. (1986). UNESCO, Paris. Personal Communication.

111. WAGNER, E.G. & LANOIX, J.N. (1959). Water Supply for Rural Areas and Small Communities. WHO, Geneva.

112. WALL, H.R. (1980). Civil Engineering, Vol 50, No 12. ASCE, New York.

113. WARNER, D.B. (1981). Social and Economic Preconditions for Water Supply and Sanitation Programmes. Wash Technical Report, No 10. US Agency for International Development, Washington, DC.

114. WHITE, A.T. (1981). Community Participation in Water Supply and Sanitation. WHO-IRC Technical Paper, No 17. WHO-IRC, The Hague.

115. WHO, (1971). International Standards for Drinking Water, Third Edition. WHO, Geneva.

116. WHO, (1983). Rural Water Supply Operation and Maintenance: Eight Questions to Ask. WHO, Geneva.

117. WHO, (1984). WHO Talks of a 4-point Action Plan. World Water, Vol 7, No 7. Thomas Telford, London.

118. WHO-IRC, (1979). Public Standpost Water Supplies, A Design Manual. WHO-IRC Technical Paper Series No 14. WHO-IRC, The Hague.

119. WHO-IRC, (1982). Practical Solutions in Drinking Water Supply and Waste Disposal for Developing Countries. WHO-IRC Technical Paper Series No 20. WHO-IRC, The Hague.

120. WHO-IRC, (1983). Small Community Water Supplies. WHO-IRC Technical Paper Series No 18. WHO-IRC, The Hague.

21. WHYTE, A.V. (1984). Community Participation: Neither Panancea or Myth. In, Water and Sanitation, Economic and Sociological Perspectives. Academic Press, London.

122. WOOD, W.E. (1983). Who will look after the village Water Supply. Waterlines, Vol 2, No 2. London.

123. WORLD BANK, (1976). Village Water Supply. World Bank, Washington, DC.

124. WORLD BANK, (1978). Observations of Rural Water Supply and Sanitation Programmes in Eight Developing Countries. Public Utilities Report No 42. World Bank, Washington, DC.

125. WORLD BANK, (1985). The International Training Network for Water and Waste Management. Water Supply and Urban Development Department, World Bank, Washington, DC.

GRAVITY FLOW WATER SYSTEMS: REASONS FOR FAILURE

J.B. POLLOCK MSc. Thesis

September 1986

REFERENCES

768

ABBREVIATIONS

ASCE	American Society of Civil Engineers
BPT	Break Pressure Tank
CWSSP	Community Water Supply and Sanitation Project
FCM	Ferro Cement
FV	Float-Valve
GI	Galvanised Iron
HDP	High Density Polyethelene
HGL	Hydraulic Grade Line
HMG	His Majesty's Government (Nepal)
ICE	Institution of Civil Engineers
IDRC	International Development Research Centre
IDTG	Intermediate Development Technology Group
IDWSSD	Internatinal Drinking Water Supply and Sanitation Decade
ILO	International Labour Office
IPHE	Institution of Public Health Engineers
IRC	International Reference Centre
IRCWD	International Reference Centre for Waste Disposal
IT	Intermediate Technology
IWES	Institution of Water Engineers and Scientists
lcd	litres per capita per day
lps	litres per second
MPLD	Ministry of Panchayat and Local Development (Nepal)
MSc	Master of Science
NRs	Nepalese Ruppees
ODA	Overseas Development Administration

OECD	Organisation for Economic Cooperation and Development
PVC	Polyvinyl Chloride
RT	Reservoir Tank
SATA	Swiss Aid For Technical Assistance
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
WEDC	Water Engineering for Developing Countries
WHO	World Health Organisation
VMSC	Village Maintenance and Sanitation Committee
VMW	Village Maintenance Worker
WRC	Water Research Centre

REFERENCES

1. AGARWAL, A et al. (1981). Water, Sanitation and Health For All? Prospects for the IDWSSD, 1981-1990. Earthscan, London.

2. AHMAN, I. (1980). National Stategies for the IDWSSD. Paper presented at the Inter-regional Seminar on Rural Water Supply, Uppsala, Sweden, October 5-16.

3. AHMED, I (1985). Technology and Rural Women. George Allen and Unwin, London.

4. ARCEIVALA, S.J. (1966). Keynote Speech in Community Water Supply and Water Distribution. Public Health Engineering Record. Indian Institution of Public Health Engineers, Calcutta.

5. BALDWIN, B. (1983). Why Present Value Calculations should not be used in choosing Rural Water Supply Technology. World Development, Vol.11, No 12.

6. BANKS, P.A. (1983). Rural Water Supply and Sanitation. In, Water Supply and Sanitation in Developing Countries. IWES, London.

7. BARKER, J. (1985). Centre for Extension Studies, Loughborough University of Technology. WEDC, MSc Lecture Notes.

8. BARRET, A.D & PESCOD, M.B (1982). Water Supply in Developing Countries: Improving on Current Practice. Journal of IWES, Vol 36, No 5. London.

9. BIFANI, P. (1986). How Kenyan Peasants, Pastoralists and Peri-urban Women See Water Problems. Waterlines, Vol 4, No 3. London.

10. BLACK, M. (1983). UNICEF News, No 116. New York.

11. BLAIKIE et al, (1980). Nepal in Crisis: Growth and Stagnation at the Periphery. Clarendon Press, Oxford, England.

12. BOURNE, P.G. (1984). Water and Sanitation, Economic and Sociological Perspectives. Academic Press, London.

13. BRADLEY, D.J (1968). Predicting the Epidemiological Effects of Changing Water Sources, Part II. East African Medical Health Journal, Vol 45, No 33. Nairobi, Kenya.

14. BROWN, A. (1986). The Task of Renovation and Operation of Water Supply in Ghana. 11th WEDC Conference Proceedings in Dar-es-Salaam. WEDC, Loughborough, UK.

15. BROWN, G.A. (1984). The IDWSSD (1981-90): The Scale of the World Problem. In, World Water '83, The World Problem. Thomas Telford Ltd., London.

16. BURNS et al, (1977). Lesotho: Village Water Supplies, An Ex-Post Evaluation, Final Report. Ross Institute of Tropical Hygiene, London.

17. BUTRICO, F.A. (1982). Water Resources in Developing Countries. Issues in Engineering, Vol. 107, No E11. ASCE, New York.

18. CAIRNCROSS, S. et al, (1980). Evaluation for Village Water Supply Planning. John Wiley and Sons, Chichester, UK.

19. CAIRNCROSS, S. & FEACHEM, M. (1978). Small Water Supplies. Bulletin No 10. The Ross Institute of Tropical Hygiene, London.

20. CAIRNCROSS, S & FEACHEM, R. (1983). Environmental Health Engineering in the Tropics: An Introductory Text. John Wiley and Sons, Chichester, UK.

21. CARR, M. (1976). Rural Women, Rural Technology and Rural Development. Populi, Journal of the UN Funds for Population Activities, Vol. 3, No 4. UN, New York.

22. CHAUHAN, S.K. (1983). Who Puts the Water in the Taps; Chapter Six, Malawi. Earthscan, London.

23. COAD, A. (1985). Conventional Water Treatment. In, Developing World Water. Grosvenor Press International, London.

24. CURTIS, N.J. (1984). Design Philosophy and Principles. In, Water Distribution Systems. IWES, London.

25. DESAI, M.K. (1985). Rural Water Supply Development in India A Success Story. In, Water Supply, Vol 3, Pergammon Press, Oxford, UK.

26. DORE, R. & MARS, Z. (Editors). (1981). Community Development. UNECO, Paris.

27. DOSSING, H. (1982). Ministry of Education, Nepal. Personal Communication.

28. DUDLEY, G.S.B.G. (1983). Operation and Maintenance. Chapter 12 in Water Supply and Sanitation In Developing Countries. IWES, London.

29. EBERSOLL, T. (1984). Maintenance; Progress for 1983/'84 Construction Season. UNICEF/MPLD, Nepal. (Unpublished).

30. The ECONOMIST, (1985). Unloved, Unuseful, Unctad. The Economist, April 13, London.

31. ELLIS, K.V. (1985). The Pretreatment of Turbid Surface Water Prior to Slow Sand Filtration. In, Water and Sanitation in Africa, 11th WEDC Conference. WEDC, Loughborough, England.

32. ELMDORF, M. & BUCKLES, P. (1980). Sociocultural Aspects of Water Supply and Excreta Disposal. World Bank, Washington D.C.

33. ELMDORF, M. (1985). Women as Decision Makers. In, Developing World Water. Grosvenor Press International, London.

34. FARRANT, T.(1985). Realistic Timetable Required for Africa. In, World Water, Vol 8, No 5. Thomas Telford, London.

35. FEACHEM, R. et al. (1978). Water Health and Development: An Inter-disiplinary Evaluation. Tri-Med Books, London.

36. FLOGSTAD, H. (1984). World Water, Vol 7, No 12. Thomas Telford, London.

37. FRANCEYS, R.W.A. (1985). WEDC, MSc Lecture Notes. Loughborough University of Technology.

38. FREEDMAN, J. (1984). World Bank Operations and Finance. In, World Water '83, The World Problem. Thomas Telford, London.

39. GLENNIE, C. (1980). MPLD/UNICEF Rural Water Supply Programme; Field Vists to Far Western and Eastern Regions, Report and Recommendations. UNICEF, Kathmandu, Nepal. (Unpublished).

40. GLENNIE, C. (1982). A Model for the Development of a Self-Help Water Supply Programme. Technology Advisory Group Working Paper - No.1. World Bank, Washington, DC.

41. GLENNIE, C. (1983). Village Water Supply in The Decade, Lessons From Field Experience. John Wiley & Sons, Chichester, England.

42. GLENNIE, C. (1985a). Gravity Flow Water Systems. In, Developing World Water. Grosvenor Press International, London.

43. GLENNIE, C. (1985b). The Status of the MPLD/UNICEF CWSS Programme in Nepal: A Final Report Based on Field Observations. UNICEF, Kathmandu, Nepal. (Unpublished).

44. GOLLADY, F.L. (1983). Economic and Social Conditions. In, Water Supply and Sanitation in Developing Countries. IWES, London.

45. GRIEVSON, M.B. (1984). Assessment of Priorities for Investment in Water Supply and Sanitation in Developing Countries. In, World Water '83, The World Problem. Thomas Telford, London.

46. GRIFFITHS, F.N.H. (1983). Urban Water Supply. In, Water Supply and Sanitation in Developing Countries. IWES, London.